



NATIONAL INSTITUTE OF AEROSPACE

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Guide to APA-Based Models**

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For

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In Robins and Delisi (2008), a linear decay model, a new IGE model by Sarpkaya (2006), and a series of APA-Based models were scored using data from three airports. This report is a guide to the APA-based models.

A list of models used in Robins and Delisi (2008), as presented in Section 3, is as follows:

APA 3.1.1	- the original APA model with a minimum circulation decay in ground effect of $\Gamma/\Gamma_0 = 1 - T/K$, $K=8$, and a modified version of APA 3.1.1 with $K = 5$.
APA 3.2.1	- APA 3.1.1 with Proctor's model for the circulation decay during the initial stages of IGE; with the same minimum decay rates as in APA 3.1.1. Proctor's model is linearly phased in between the times of $0.25T$ and $0.4T$, where T is the time scale b_0/V_0 , b_0 and V_0 being the initial separation and descent speed of the vortices.
APA 3.2.1E	- APA 3.2.1 with a minimum decay rate equal to the environmental decay rate at the beginning of IGE or $\Gamma/\Gamma_0 = 1 - T/K$, $K=8$, if the environmental rate is less than this; also scored was a version of APA 3.2.1E with $K=5$.
APA 3.2.2	- An alternate version of APA 3.2.1 ($K=5$ only) where the onset of Proctor's model occurs exactly at a time of $0.25T$.
APA 3.2.2E	- An alternate version of APA 3.2.1E ($K=5$ and 6) where the onset of Proctor's model occurs exactly at a time of $0.25T$.
Sarpkaya's IGE Model	- described by T. Sarpkaya in a report entitled "A Physics-based Real-time IGE Model of Aircraft Wake Vortices Subjected to Crosswind and Stratification."
$1 - T/5$ Linear Decay	- APA 3.1.1 with the IGE non-dimensional decay rate equal to $1 - T/5$.

The source codes for models APA 3.1.1, APA 3.2.1, APA 3.2.1E, APA 3.2.2, APA 3.2.2E, and Sarpkaya's IGE Model are provided on an accompanying CD-ROM disk. The one-line code change that determines the value of K for the APA 3.X.X models is clearly indicated in the code for the respective models. To find this code,

simply search for “C*****” in files ge1pth.f and ge2pth.f to find the code that sets K.

The code change required to transform APA 3.1.1 to the $1 - T/5$ Linear Decay model is as follows:

Original Code from APA 3.1.1 files ge1pth.f and ge2pth.f:

```
C
C*****      FOLLOWING CODE FOR K=8 *****
      DGMIN = 0.125*TWOPI*VZIN*VZIN
C*****      FOLLOWING CODE FOR K=5 *****
CCC      DGMIN = 0.2*TWOPI*VZIN*VZIN
C*****
C
      IF(DELGAM.LT.DGMIN) DELGAM=DGMIN
C
      DGFAC = DELGAM/GAM(1)
      DO I=1,NPTS
        DGAM(I) = GAM(I) * DGFAC
      ENDDO
C
```

Modified Code for the $1 - T/5$ Linear Decay Model:

```
C
      DELGAM = 0.2*TWOPI*VZIN*VZIN
C
      DGFAC = DELGAM/GAM(1)
      DO I=1,NPTS
        DGAM(I) = GAM(I) * DGFAC
      ENDDO
C
```

The input parameters required for all code versions are the same as described for LINES 3-10 in Robins and Delisi, 2005.

References

- R.E. Robins and D.P. Delisi, 2008. Evaluation of Real-Time Wake Vortex Prediction Models and Recommendations for IGE. NorthWest Research Associates Report R366, Seattle, WA, January.
- R.E. Robins and D.P. Delisi, 2005. Software Package for Simulation of Trailing Vortex Evolution using the Algorithms APA (version 3.2), TDAWP, and D2P. NorthWest Research Associates Report R291, Bellevue, WA, February.
- T. Sarpkaya, 2006. A Physics-Based Real-Time IGE Model of Aircraft Wake Vortices Subjected to Crosswind and Stratification. Hydrodynamics Applications, Inc. report to NASA, October.